

## **REMARKS**

The Office Action dated October 25, 2007 has been received and carefully noted. The above amendments to the specification and claims, and the following remarks, are submitted as a full and complete response thereto.

Claims 1-3 have been amended to more particularly point out and distinctly claim the subject matter of the invention. No new matter has been added. Therefore, claims 1-3 are currently pending in the application and are respectfully submitted for consideration.

The Office Action stated that the Information Disclosure Statement, filed June 14, 2006, fails to comply with the provisions of 37 C.F.R. §§1.97-1.98, and MPEP § 609 because the entry "AL" does not provide an author, title and date for the cited reference. (see Office Action at page 2, paragraph 2). An Information Disclosure Statement, which is enclosed with this Response, identifies the authors of the cited reference as "R. L. Graham, D. E. Knuth, and O. Patashnik;" identifies the title of the cited reference as "Concrete Mathematics;" identifies the publisher of the cited reference as "Addison-Wesley;" and identifies the date of the cited reference as "1989." Thus, Applicants respectfully submit that the Information Disclosure Statement moots the objection, and respectfully request that the objection be withdrawn.

The Office Action objected to the specification for the following minor informality: on page 8, line 9, the specification recites "the power from," where it appears "the power form" was intended. (see Office Action at page 2, paragraph 3). The

specification has been amended to recite “the power form” instead of “the power from.” Applicants respectfully submit that this amendment moots the objection, and respectfully request that the objection be withdrawn.

The Office Action rejected claim 2 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. Specifically, the Office Action stated that one reasonably skilled in the art could not make or use the invention from the disclosure in the specification, coupled with information known in the art, without undue experimentation because the claim recites in line 14, “ $h_{ij}^{(p)}$ ,” and the meaning of the term does not appear to be described in the specification. (See Office Action at pages 2-3, paragraph 4). This rejection is respectfully traversed for the following reasons.

The specification discloses that in a first stage of an embodiment of the invention, the first recurrence is run from  $j = 1$  up to  $j = N - K$ , where  $N$  and  $K$  are previously defined. (see Specification at paragraph 0011). The specification further discloses that, in the embodiment of the invention, the first recurrence is expressed in terms of  $j$ . (see Specification at paragraph 0011). Furthermore, the specification discloses that, in an embodiment of the invention, “ $h_i^{(p)} = (h_{ij}^{(p)}) = (h_{i,0}^{(p)}, h_{i,1}^{(p)}, \dots)$ ,” and that “ $h_i = h_{i,0}^{(N)}$  where  $0 \leq i \leq N$ .” (see Specification at paragraphs 0013, 0051). Therefore, Applicants respectfully submit that one of ordinary skill in the art would understand the meaning of the term “ $h_{ij}^{(p)}$ ,” and therefore, one of ordinary skill in the art could make or use the invention from the disclosure in the specification, coupled with information known in the

art, without undue experimentation. For the above reasons, Applicants respectfully request that the rejection be withdrawn.

The Office Action rejected claims 1-3 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, the Office Action stated that, regarding claims 1 and 3, the claims recite in line 1, "FIR," but the acronym is not defined in the claims. (see Office Action at page 3, paragraph 5). Claims 1 and 3 has been amended to recite "finite impulse response (FIR)" instead of "FIR," in the first instance. Applicants respectfully submit that these amendments moot the rejection, and respectfully request that the rejection be withdrawn.

The Office Action rejected claims 1-3 under 35 U.S.C. § 101 because the claimed invention is directed to non-statutory subject matter. Regarding independent claim 1 and dependent claim 2, the Office Action stated that, "the claim appears to be entirely an abstract idea, and as such is non-statutory." The Office Action further stated that, "an ordinary artisan interpreting the claim in light of the specification would reasonably interpret the claims as a set of abstract operations." Finally, the Office Action stated that, "the program does not appear to produce a tangible result to support a practical application, nor produce a physical transformation." (see Office Action at page 4, paragraph 7). Regarding independent claim 3, the Office Action stated that, "the claim is directed to a program, which appears to be functional descriptive material per se, and therefore, the claim is directed to non-statutory material." The Office Action further

stated that, “the program does not appear to produce a tangible result to support a practical application.” (see Office Action at page 4, paragraph 7).

With respect to claims 1 and 2, Applicants respectfully traverse this rejection because claims 1 and 2 do not recite abstract ideas, and the claims do produce a tangible result, namely, “extracting impulse response coefficients of a universal maximally flat FIR filter,” as recited in claim 1.

The Office Action stated that, with respect to claim 1, “[n]one of the claim limitations appear to expressly or inherently require tangible physical components.” (see Office Action at page 4, paragraph 7(a)). Applicants note that the implementation of the claim requires computational resources in the form of hardware capability in order to perform arithmetic operations, and additional hardware resources for storage of the intermediate and final numerical results. Specifically, the specification discloses that the invention “relates to a computational method ... and to a computational program for the same.” (see Specification at 0002). Furthermore, the specification describes that a common problem with computations involving binomial coefficients is that they introduce very large integers to the intermediate steps of the computation, and that there are cases when limitations on hardware and software resources dictate the use of efficient means in computation of filter coefficients, and thus, disclose that embodiments of the invention require tangible physical components, such as hardware resources. (see Specification at 0004). Finally, the specification discloses that an embodiment of the invention is mostly suitable for real-time generation of the coefficients on a DSP chip

because it may be easily implemented in a computational environment that has restrictions on the available hardware and software resources. (see Specification at 0074). Given these physical components, the claim transforms an initial sequence of trivial numbers, which is stored in the form of a numerical array embodied on a computer readable medium, to a final sequence of numbers for use in the physical realization of maximally flat FIR digital filters.

The Office Action further stated that claim 1 “appears to be entirely an abstract idea, and as such is non-statutory.” (see Office Action at page 4, paragraph 7(a)). Applicants respectfully emphasize that the tangible result produced by claim 1 is a finite-length sequences of numbers. The numbers are the exact values of the weighting coefficients that yield maximally flat FIR filter characteristics. When used as weighting coefficients, also known as impulse response coefficients, in an FIR digital filter, a smoothing effect is produced by the action of the coefficients. This filtering effect, which is produced by the steps of the claim, can be used to smooth and process arbitrary digital sequences.

Furthermore, the claims enables one to generate, on a computable readable medium using hardware resources, and in a computationally efficient and simple manner, the coefficients described above. These coefficients can be produced for any arbitrarily given filter specifications pertaining to the maximally flat type.

Thus, claim 1 produces a tangible result, which is the impulse response coefficients, and supports a practical application, which is smoothing of digital data with a frequency response of a maximally flat type.

Applicants respectfully submit that claim 2 depends upon claim 1, and thus, the reasons why claim 1 recites statutory subject matter equally applies to claim 2 as well. Thus, for the reasons discussed above, Applicants submit that claims 1 and 2 are directed to statutory subject matter, and respectfully request that the rejection be withdrawn.

With respect to claim 3, the Office Action stated that “the claim must produce either a physical transformation or have a practical application having a concrete, useful and tangible result.” Applicants respectfully submit that MPEP 2106.01 states that “[w]hen functional descriptive material is recorded on some computer-readable medium, it becomes structurally and functionally interrelated to the medium and will be statutory in most cases since use of technology permits the function of the descriptive material to be realized.” (see MPEP 2106.01; see also *In re Lowry*, 32 F.3d 1579, 32 USPQ2d 1031; *In re Warmerdam*, 33 F.3d 1354, 31 USPQ2d 1754). Applicants further submit that claim 3 has been amended to recite “a program for computing FIR filter coefficients embodied on a computer readable medium,” and that a program for computing FIR filter coefficients embodied on a computer readable medium has the capability of transforming an initial FIR digital filter that can merely receive digital data, but cannot produce useful digital data as its output, to a useful maximally flat digital filter that receives digital data and processes it to produce a smoothed version. Thus, for the reasons discussed above,

Applicants respectfully submit that the claim amendment moots the rejection, and respectfully request that the rejection be withdrawn.

The Office Action rejected claim 1 under 35 U.S.C. § 103(a) as being unpatentable over Saed Samadi et al., “Universal Maximally Flat Lowpass FIR Systems,” July 2000, IEEE Transactions on Signal Processing, Volume 48, Number 7 (“Samadi Universal”), and Saed Samadi et al., “Filter-Generating Systems,” March 2000, IEEE Transactions on Circuits and Systems-II: Analog and Digital Signal Processing, Volume 47, Number 3 (“Samadi Filter-Generating”). The Office Action took the position that Samadi Universal discloses all the elements of the claims with the exception of “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value,” and “extracting impulse response coefficients of the universal maximally flat FIR filter from a resultant of the second operation,” as recited in claim 1. The Office Action then cited Samadi Filter-Generating as allegedly curing the deficiencies of Samadi Universal. The rejection is respectfully traversed for at least the following reasons.

Claim 1, upon which claim 2 is dependent, recites a method of computing finite impulse response (FIR) filter coefficients. The method includes the step of inputting a filter order of a universal maximally flat FIR filter, a number of zeros at  $z=-1$ , and a parameter for a group delay at  $z=1$ . The filter order is a positive integer, the number of zeros is an integer equal to or more than zero, and the parameter is a rational number. The method further includes the step of executing a first operation by a first recurrence

formula which includes parameters for the filter order, the number of zeros, and the group delay, and provides coefficients in Bernstein form representation of a transfer function of the universal maximally flat FIR filter. The method further includes the step of executing a second operation by a second recurrence formula comprising additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value. The method further includes the step of extracting impulse response coefficients of the universal maximally flat FIR filter from a resultant of the second operation.

Claim 3 recites a program for computing finite impulse response (FIR) filter coefficients embodied on a computer readable medium. The program causes a computer to execute the step of determining every element of a single-dimension array B' using a filter order N, a number of zeros K at  $z=-1$ , and a parameter d for a group delay at  $z=1$ , by changing in sequence an index j from 1 to N-K in a recurrence formula  $B'[j] = (-1) \times \{(2d)B'[j-1] + (j-1)B'[j-2]\} / (N - j + 1)$ , the single-dimension array having N+1 elements B'[j] where  $0 \leq j \leq N$ , in which an element B'[0] thereof is initialized to 1 and all the elements thereof except the element B'[0] are initialized to zero. N is a positive integer of a universal maximally flat FIR filter, K is an integer equal to or more than zero, d is a rational number, and N, K, and d are provided by inputs. The program further causes a computer to execute the step of determining every element of a three-dimension array r by sequentially changing, in the order of indexes j, i, p, an index j from 0 to N-p, and an index i from 0 to p, an index p from 1 to N in a recurrence formula  $r[p,i,j] = (r[p-1,i-1,j] - r[p-1,i-1,j+1]) / 2 + (r[p-1,i,j] + r[p-1,i,j+1]) / 2$ , the three-dimension array r having N<sup>3</sup>

elements  $r[p,i,j]$  where  $0 \leq p \leq N$ ,  $0 \leq i \leq N$ ,  $0 \leq j \leq N$ , in which elements  $r[0,0,j]$  thereof where  $0 \leq j \leq N-K$  are initialized to elements of the single-dimension array  $B'[j]$  where  $0 \leq j \leq N-K$ , and all the elements thereof except the elements  $r[0,0,j]$  are initialized to zero. The program further causes a computer to execute the step of extracting elements  $r[N,i,0]$  of the three-dimension array  $r$  where  $0 \leq i \leq N$  as the impulse response coefficients of the universal maximally flat FIR filter.

Thus, according to embodiments of the invention, impulse response coefficients of a universal maximally flat FIR filter are computed efficiently in a short period of time. Furthermore, the method does not involve any form of binomial coefficients, which require additional hardware and software resources. Moreover, the method requires less number of arithmetical operations compared to a direct evaluation using the closed-form formula. Finally, according to embodiments of the invention, the method may be easily implemented in a computational environment that has restrictions on the available hardware or software resources.

As will be discussed below, the combination of Samadi Universal and Samadi Filter-Generating fails to disclose or suggest all of the elements of the claims, and therefore fails to provide the advantages and features discussed above.

Samadi Universal discloses a simplified formula for the transfer function of FIR digital filters. Samadi Universal further discloses that the formula is derived from Baher's analytical procedure. The formula takes in a set of parameters and computers impulse response coefficients. An explicit expression for the class of FIR systems is

disclosed that contains non-symmetric filters, linear-phase maximally flat filters, and Lagrange interpolators. (see Samadi Universal at page 1956, Abstract and Section I).

Samadi Filter-Generating discloses a technique for generating and implementing families of digital filters using multidimensional systems. The technique utilizes the recursive relationship existing in some classes of FIR digital filters. Samadi Filter-Generating discloses that for some families of FIR digital filters, it is possible to derive infinite-impulse response (IIR) filter-generating systems of low orders that generate the whole class of the filters as their impulse-response sequence. Samadi Filter-Generating further discloses a concrete example of a family of filters with a rational generating function. (see Samadi Filter-Generating at page 214, Section I).

Applicants respectfully submit that Samadi Universal and Samadi Filter-Generating, whether considered individually or in combination, fail to disclose, teach, or suggest, all of the elements of the present claims. For example, the combination of Samadi Universal and Samadi Filter-Generating fails to disclose, teach, or suggest, at least, “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value,” as recited in claim 1.

The Office Action correctly concludes that Samadi Universal fails to disclose or suggest “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value;” and “extracting impulse response coefficients of the universal maximally

flat FIR filter from a resultant of the second operation,” as recited in claim 1. (see Office Action at page 6, paragraphs 10(j)-(l)). Thus, Samadi Universal fails to disclose, teach, or suggest, at least, “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value,” and “extracting impulse response coefficients of the universal maximally flat FIR filter from a resultant of the second operation,” as recited in claim 1.

Samadi Filter-Generating does not cure all the deficiencies of Samadi Universal, as Samadi Filter-Generating also fails to disclose, teach, or suggest, at least, “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value,” as recited in claim 1.

As discussed above, Samadi Filter-Generating discloses an example of a transfer function of a low-pass maximally flat filter. (see Samadi Filter-Generating at page 214, Section I). Samadi Filter-Generating further discloses a transfer function of low pass-maximally flat filters and further discloses a Bernstein representation of said transfer function. (see Samadi Filter-Generating at pages 218-219, Section V). However, Samadi Filter-Generating fails to disclose a second operation by a second recurrence formula using the result of the first operation as the initial value of the second operation because Samadi Filter-Generating fails to disclose that the Bernstein recursive representation of

the transfer function uses a result from a previous operation as an initial value. (see Samadi Filter-Generating at 218-219, Section V).

In contrast, in an embodiment of the present invention, the specification discloses that the resultant of a first operation is expressed as  $B' = \{1, b_1', \dots, b_{N-K}', 0, \dots, 0\}$  where the number of zeros is K, and the specification further discloses that, by using a resultant of the first operation as an initial value, the computer executes the second operation by the second recurrence formula composed of additions, subtractions, and divisions by 2 to extract impulse response coefficients of the universal maximally flat FIR filter. (see Specification at 0012).

Furthermore, the recurrence formulas (16) and (17) of Samadi Filter-Generating give rise to only one kind of maximally flat filter, i.e. linear-phase maximally flat filters of an even order. (see Samadi Filter-Generating at page 214, Section I, "As a concrete example, we show that at least one well-known family of FIR digital filters, the linear-phase maximally flat FIR filters, possesses very simple rational filter-generating functions. We use this function to derive array structures for modular realization of the member filters.") In contrast, claim 1 of the present invention produces the coefficients for all types of filters including non-linear phase filters, odd order filters, even order filters, and Lagrange interpolators through a meaningful choice of the parameters N, K, and d. In the present invention, there is no restriction on the values of the parameters as long as N and K are integers, with N being positive, and K being nonnegative, and the group delay parameter d being a real number.

Thus, Applicants respectfully submit that it is not a trivial or obvious matter to derive claim 1 from the simple example given in Samadi Filter-Generating, which is only good and valid for a very restricted subfamily, because claim 1 has a much wider coverage than what is disclosed in Samadi Filter-Generating.

Thus, Applicants respectfully submit that Samadi Filter-Generating, whether considered individually or combined with Samadi Universal, fails to disclose, teach, or suggest, at least, “executing a second operation by a second recurrence formula composed of additions, subtractions, and divisions by 2, by using a resultant of the first operation as an initial value,” as recited in claim 1.

Therefore, for at least the reasons discussed above, the combination of Samadi Universal and Samadi Filter-Generating fails to disclose, teach, or suggest, all of the elements of claim 1. For the reasons stated above, Applicants respectfully request that this rejection be withdrawn.

Furthermore, Applicants respectfully submit that the Office Action has failed to establish a prima facie case of obviousness because it has failed to provide a motivation to combine the cited prior art references of Samadi Universal and Samadi Filter-Generating.

As reiterated by the Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. \_\_\_, 82 USPQ2d 1385 (2007), the framework for the objective analysis for determining obviousness under 35 U.S.C. § 103 is stated in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). Obviousness is a question of law based on underlying

factual inquiries. The factual inquiries are: (a) determining the scope and content of the prior art; (b) ascertaining the differences between the claimed invention and the prior art; and (c) resolving the level of ordinary skill in the pertinent art. (see *KSR International Co. v. Teleflex Inc.*, 550 U.S. \_\_\_, 82 USPQ2d 1385 (2007); *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966); see also MPEP 2141).

The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. § 103 should be made explicit. The court stated that “rejections on obviousness cannot be sustained by mere conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” (see *KSR*, 550 U.S. at \_\_\_, 82 USPQ2d at 1396; see also MPEP 2141).

The Office Action stated that the motivation to use the cited reference of Samadi Filter-Generating with the cited reference of Samadi Universal “would have been the multiple benefits recited in [Samadi Filter-Generating] including that filter generating systems are very efficient tools for systematic generation of various modular structures for an associated family of filters, which would have been recognized as a benefit by an ordinary artisan.” (see Office Action at pages 5-6, paragraph 10(d)). The Office Action further stated that it would have been obvious to the ordinary artisan at the time of the invention to use the cited reference of Samadi Filter-Generating with the cited reference of Samadi Universal to produce the claimed invention. (see Office Action at page 7, paragraph 10(p)).

However, each cited reference is directed toward a single operation (comprising of a single recurrence formula) directed to produce a final result. Neither of the cited references discloses or suggests that additional operations would be necessary, or beneficial, to reach a similar result. Furthermore, neither cited references discloses or suggests that each operation containing a recurrence formula could be combined with a second operation also containing a recurrence formula to produce impulse response coefficients. Thus, the Office Action fails to identify a motivation to combine the operation of Samadi Universal with the operation of Samadi Filter-Generating to create a hypothetical two-step operation using the resulting value of the first operation as the initial value of the second operation.

Additionally, the Office Action's statement that the motivation to combine is the multiple benefits recited in Samadi Filter-Generating, including that filter generating systems are very efficient tools for systematic generation of various modular structures for the associated family of filters, does not take into consideration that the inventors of the present invention are not utilizing the cited reference of Samadi Filter-Generating as disclosed in the existing literature. Samadi Filter-Generating explicitly requires that an artisan derive a multi-dimensional and rational transfer function for an entire family of the filters. In contrast, in claim 1, the filter coefficients are produced in two steps without making any use of any form of a multi-dimensional transfer function of the family.

Furthermore, the two recurrence formulas, disclosed in claim 1, were not known at the time of invention. They have been specifically invented, without using the cited

reference of Samadi Filter-Generating, for facilitating the process of computation of the coefficients. The benefits of claim 1 are superior to the perceived benefits of the approach based on Samadi Filter-Generating because an approach based on Samadi Filter-Generating does not yield a rational transfer function valid for all values of the parameters.

Finally, with respect to the Office Action's statement that it would have been obvious to one of ordinary skill in the art at the time of the invention to use the cited reference of Samadi Filter-Generating with the cited reference of Samadi Universal, Applicants respectfully emphasize that the combination of the cited references cannot produce the claimed invention of claim 1. Samadi Filter-Generating can be used to produce the filter coefficients, as demonstrated in Samadi Universal, only in the very restricted case where the value of parameter  $d$  is so that  $N/2+d$  becomes an integer. Otherwise, for all other cases, it is not possible to combine the two approaches and produce the filter coefficients with the same benefits as those of the present invention.

Thus, Applicants respectfully submit that the Office Action has failed to establish a prima facie case of obviousness because it has failed to provide a motivation to combine the cited references of Samadi Universal and Samadi Filter-Generating. For the reasons stated above, Applicants respectfully request that this rejection be withdrawn.

The Office Action objected to claim 2 as being dependent upon a rejected base claim and stated that "any indication of allowability [sic] is withheld pending resolution of the outstanding rejections." (see Office Action at page 7, paragraphs 12-13). Claim 2

depends upon claim 1. Applicants respectfully submit that claim 2 has not been amended to include all of the limitations of the base claims, because Applicants have respectfully traversed the rejections to claims 1, and the other rejections to claim 2, as described above. Accordingly, it is respectfully requested that claim 2 be allowed.

Applicants respectfully submit that there are no additional rejections to claim 3 besides the previously discussed rejections, which have been traversed, as discussed above. Therefore, Applicants assume that claim 3 states allowable subject matter, and respectfully request that claim 3 be allowed. If Applicants are in error, then it is respectfully requested that a new Non-Final Office Action be issued detailing why claim 3 is not in condition for allowance.

For at least the reasons discussed above, Applicants respectfully submit that the cited prior art references fails to disclose or suggest all of the elements of the claimed invention. These distinctions are more than sufficient to render the claimed invention unanticipated and unobvious. It is therefore respectfully requested that all of claims 1-3 be allowed, and this application passed to issue.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicants' undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,



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